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THE WORK OF THE BELLE FOURCHE RECLAMATION PROJECT EXPERIMENT FARM IN 1917

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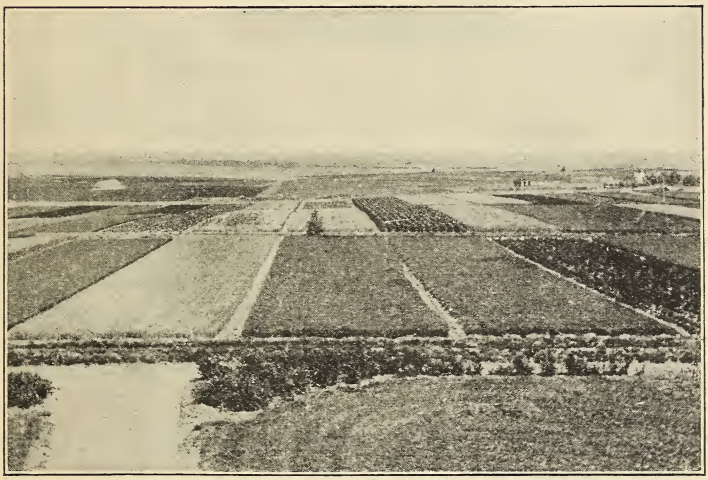

Experimental Plats for Irrigated Field Crops on the Belle Fourche Experiment Farm

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THE WORK OF THE BELLE FOURCHE RECLAMATION PROJECT EXPERIMENT FARM IN 1917.

CONTENTS.

OBJECTS AND CHARACTER OF THE INVESTIGATIONS.

THE BELLE FOURCHE EXPERIMENT FARM consists of 360 acres of land on the Belle Fourche Reclamation Project, near Newell, S. Dak., set aside by the Department of the Interior for experimental use. The experimental work is designed to secure information needed in the development of agriculture on the Belle Fourche Reclamation Project and adjacent areas. It relates chiefly to the crops of local importance and includes experiments in crop rotation and tillage, tests of grain and forage crops, experiments in hog and sheep production, tests of pasture grasses, of trees for windbreaks and ornamental plantings, of garden vegetables, and of orchard and small fruits. Figure 1 shows the arrangement of the fields and the location of the experiments in 1917.

The farm is in charge of the Office of Western Irrigation Agriculture of the Bureau of Plant Industry, and facilities are provided for special investigations carried on by other agencies of the Department of Agriculture. The Office of Dry-Land Agriculture Investigations uses about 20 acres of land above the canal for rotation and tillage experiments. The Office of Cereal Investigations has charge of the variety testing and breeding of small grains. The Office of Alkali and Drought Resistant Plant Investigations does variety testing and breeding of forage crops and conducts studies of the water requirements of the different varieties and strains tested. These three offices have assistants detailed to the farm to supervise the work. The Biophysical Laboratory cooperates in all climatological and physical observations. This work includes the measurements of rainfall, wind velocity, evaporation, temperature, and soil moisture. The testing of trees for wood-lot and windbreak purposes is carried on in cooperation with the Forest Service.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

The precipitation in 1917 was 13.32 inches, which was 0.56 of an inch less than the average for the last 10 years at the experiment farm. The ground had a fair covering of snow from December to March, and most of the precipitation came before June 1. This made spring work exceedingly difficult, as the frequent rains made it next to impossible to work in the fields. Owing to the cold and wet

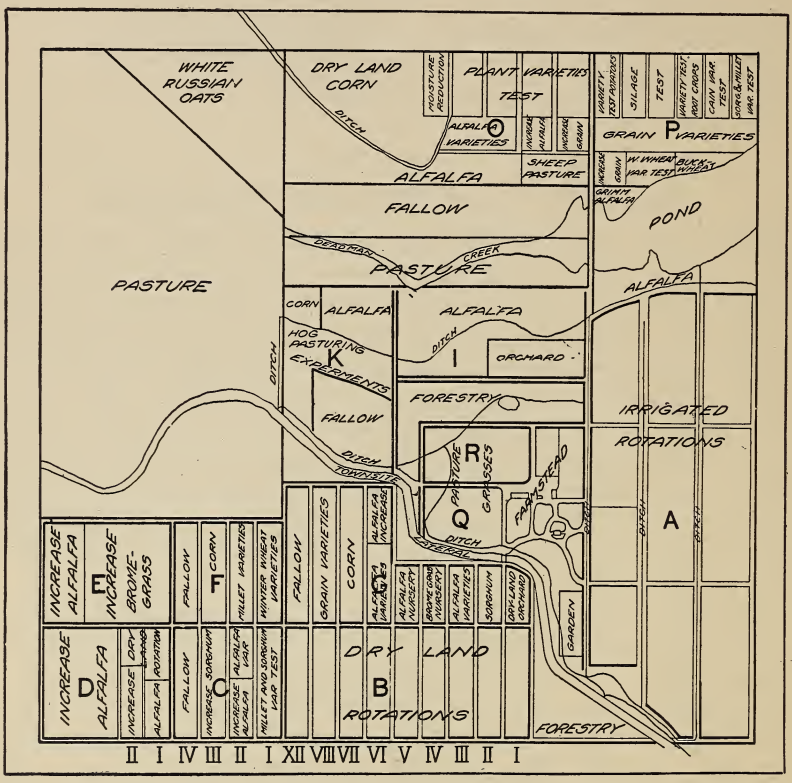

FIG. 1.—Diagram of the Belle Fourche Experiment Farm, showing the arrangement of the fields and the location of the crop experiments in 1917.

spring the crops were slow in getting started. The precipitation after June 1 came in such small quantities that little benefit was derived from it. Consequently, very poor stands of all crops that were planted late on spring plowing were secured. It was necessary to irrigate oftener than has been the practice in previous years. Irrigation water was available at all times. The project was free from serious plant or animal diseases, and there were no hailstorms during the season. The last spring frost occurred on May 31 and the first fall frost on October 8, there being a frost-free period of 130 days, which was two days less than the average for 10 years.

Table I presents a summary of the climatological observations made at the Belle Fourche Experiment Farm from 1908 to 1917, inclusive.

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1917, inclusive.*

PRECIPITATION (INCHES.)

Year.	Jan..	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1908	0.20	0.19	1.65	1.16	3.95	1.47	1.26	0.62	0.52	2.03	0.20	0.91	14.16
1909	.17	.23	.19	.84	3.87	5.59	2.45	.55	1.07	.76	73	1.28	17.73
1910	.73	.70	.93	1.57	1.26	1.51	1.42	1.03	2.92	.27	.11.	.10	12.25
1911	.13	.05	.09	.17	.45	.50	.80	1.86	.92	.39	.98	.30	6.64
1912	.24	.10	.71	2.32	2.26	.29	3.20	2.80	3.49	.51	.04	.13	16.09
1913	.57	.24	99	.25	1.98	3.10	.35	.26	2.38	1.86	.10	.45	12.53
1914	Trace.	1.00	.29	1.09	2.22	2.09	1.34	1.12	.35	1.77	0	.43	11.70
1915	.92	1.01	.16	2.58	2.32	4.74	5.74	.44	1.26	1.25	.43	.17	21.02
1916	.36	.23	.98	.64	3.17	2.19	2.01	2.02	.20	.99	.33	.28	13.40
1917	.92	.74	.27	2.51	3.71	.97	.80	1.67	.35	.46	0	.92	13.32
Average	.42	.45	.63	1.31	2.52	2.25	1.94	1.24	1.35	1.03	.29	.50	13.88

EVAPORATION (INCHES).

1908	.....	.....	.....	5.53	5.92	6.82	8.08	7.87	6.75	.....	.....	.....	40.97
1909	.....	.....	.....	3.65	6.42	5.86	7.70	8.25	5.09	.....	.....	.....	36.88
1910	.....	.....	.....	5.41	5.31	8.98	10.42	7.30	4.31	.....	.....	.....	41.73
1911	.....	.....	.....	4.65	8.30	10.24	10.71	6.68	6.11	.....	.....	.....	46.69
1912	.....	.....	.....	4.85	6.42	8.18	7.92	6.60	3.71	.....	.....	.....	37.74
1913	.....	.....	.....	4.71	4.30	7.05	8.24	8.14	4.71	.....	.....	.....	37.15
1914	.....	.....	.....	3.37	5.13	6.71	8.74	6.97	4.19	.....	.....	.....	35.11
1915	.....	.....	.....	4.45	2.97	4.61	5.35	5.11	3.95	.....	.....	.....	26.44
1916	.....	.....	.....	3.68	5.26	5.13	7.51	5.43	5.42	.....	.....	.....	32.43
1917	.....	.....	.....	2.02	4.70	6.27	9.54	6.98	5.31	.....	.....	.....	34.82
Average	.....	.....	.....	4.23	5.47	6.99	8.42	6.93	4.95	.....	.....	.....	37.00

WIND VELOCITY (MILES PER HOUR).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Mean:												
1908	.....	.....	.....	.....	8.3	7.2	5.0	6.8	6.5	.....	.....	.....
1909	.....	.....	.....	9.1	10.1	6.2	6.0	5.6	5.7	6.3	5.5	.....
1910	.....	.....	6.3	9.2	8.2	9.3	7.7	6.6	6.2	7.1	6.5	9.2
1911	7.5	5.8	9.6	9.2	11.6	9.1	7.9	7.3	7.7	.....	10.0	7.6
1912	6 9	7.3	6.6	9.5	11.1	7.6	6.0	6.9	7.6	.....	.....	.....
1913	.....	.....	.....	6.2	5.9	6.8	5.8	5.1	4.5	.....	.....	.....
1914	.....	.....	.....	8.2	7.7	6.7	5.0	5.0	6.2	.....	.....	.....
1915	.....	.....	.....	.....	7.4	6.2	5.0	4.1	5.9	.....	.....	.....
1916	.....	.....	.....	7.8	8.7	7.3	5.1	4.4	6.2	.....	.....	.....
1917	.....	.....	.....	7.8	5.7	6.3	5.3	4.2	5.1	.....	.....	.....
Maximum:												
1908	.....	.....	.....	.....	19.6	12.1	12.9	9.0	13.8	.....	.....	.....
1909	.....	.....	.....	26.8	21.7	12.9	11.6	11.8	9.8	13.8	15.0	.....
1910	.....	.....	18.9	23.8	22.0	19.4	17.6	17.6	12.1	18.3	16.7	28.0
1911	18.8	11.4	19.6	18.6	19.4	20.7	19.4	15.2	15.9	.....	21.7	15.0
1912	17.5	16.7	18.8	24.9	25.3	17.5	10.0	12.4	26.3	.....	.....	.....
1913	.....	.....	.....	16.5	12.4	18.9	14.4	9.0	13.8	.....	.....	.....
1914	.....	.....	.....	15.6	23.0	15.1	9.9	13.1	14.5	.....	.....	.....
1915	.....	.....	.....	.....	15.4	13.0	10 8	9.4	15.6	.....	.....	.....
1916	.....	.....	.....	20.5	22.7	13.5	8.7	8.1	14.0	.....	.....	.....
1917	.....	.....	.....	15.4	12.1	14.3	10.4	9.0	9.5	.....	.....	.....
Minimum:												
1908	.....	.....	.....	.....	2.1	1.7	2.5	2.9	.....	.....	.....	.....
1909	.....	.....	.....	2.5	2.6	2.9	2.5	2.5	2.5	2.1	.9	.....
1910	.....	.....	1.7	3.1	1.6	3.1	3.0	2.9	2.2	2.5	2.5	1.8
1911	1.2	.8	2.4	3.3	3.9	4.5	2.8	2.6	2.5	.....	1.3	2.1
1912	.8	2.1	1.8	3.0	2.9	2.8	3.0	2.1	1.5	.....	.....	.....
1913	.....	.....	.....	1.3	1.2	2.4	1.7	1.9	.9	.....	.....	.....
1914	.....	.....	.....	4.0	2.0	2.9	1.6	2.1	2.2	.....	.....	.....
1915	.....	.....	.....	.....	2.0	2.0	1.5	1.8	1.5	.....	.....	.....
1916	.....	.....	.....	2.0	2.0	2.2	2.1	1.6	2.3	.....	.....	.....
1917	.....	.....	.....	2.4	1.1	1.7	2.3	1.6	1.5	.....	.....	.....

TABLE I.—*Summary of climatological observations at the Belle Fourche Experiment Farm, 1908 to 1917, inclusive.*

MONTHLY TEMPERATURE (° F.).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Mean:												
1908				48	52	63	73	68	64	45	37	22
1909	12	23	32	38	52	66	70	75	61	46	21	10
1910	18	8	46	51	52	68	76	68	59	51	31	25
1911	20	22	39	42	58	73	71	65	59	43	25	20
1912	12	25	19	47	55	66	70	68	52	45	38	28
1913	13	17	23	48	53	66	70	74	59	42	37	23
1914	27	14	33	43	55	65	76	69	62	49	39	15
1915	16	19	21	52	51	58	64	66	56	50	34	25
1916	5	22	34	42	52	60	77	67	58	43	32	
1917	13	11	25	40	50	62	75	67	60	42	41	13
Maximum:												
1908				89	79	90	100	101	105	82	75	49
1909	50	51	65	73	84	95	100	105	96	84	73	49
1910	45	46	87	89	81	108	109	101	97	91	67	52
1911	59	61	78	88	90	101	105	100	94	82	58	51
1912	44	49	70	78	84	101	94	95	94	85	70	57
1913	48	62	54	89	95	98	101	104	97	80	64	51
1914	61	60	70	78	85	98	104	102	101	88	71	48
1915	53	40	50	83	84	84	88	97	100	81	68	57
1916	53	57	76	71	92	89	103	96	98	81	71	
1917	48	43	65	74	91	100	108	100	88	82	72	55
Minimum:												
1908				5	29	39	43	39	22	22		−12
1909	−24	−19	12	6	22	45	41	45	31	11	− 7	−23
1910	−19	−26	22	24	27	36	44	32	30	13	− 8	−13
1911	−22	− 7	8	7	23	43	41	32	35	− 1	− 8	−25
1912	−32	−12	−15	22	32	39	40	47	24	22	11	2
1913	−32	−14	−20	24	26	45	42	45	29	14	14	− 1
1914	− 1	−28	4	8	30	44	48	40	35	25	9	−21
1915	−26	−11	− 9	26	28	33	41	40	30	21	7	−13
1916	−37	−12	−17	17	25	35	49	42	28	18	−18	
1917	−29	−36	−11	19	28	36	45	39	34	12	10	−31

KILLING FROSTS.

Year.	Last in spring.	First in fall.	Frost-free period (days).	Year.	Last in spring.	First in fall.	Frost-free period (days).
1908	May 21	Sept. 22	128	1914	May 12	Oct. 4	145
1909	May 18	Sept. 24	128	1915	May 21	Sept. 14	116
1910	May 21	Sept. 26	127	1916	May 16	...do	121
1911	May 12	Oct. 4	146	1917	May 31	Oct. 8	130
1912	May 4	Sept. 25	144				
1913	May 6	Sept. 24	141	10-year average			132

AGRICULTURAL CONDITIONS.

The area from which crops were harvested on the project in 1917 was 50,026 acres, included in 825 farms, an increase of 3,117 acres and 23 farms over 1916. The total irrigable area of the 825 farms reported in 1917 was 67,826 acres. There was a slight decrease in the acreage of corn and wheat and some increase in the acreage of sugar beets. The total value of the crops produced on the project in 1917 was $1,171,239, an increase of $613,897 over that of 1916. The average value per acre of all crops was estimated at $23.50 in 1917 and $11.88 in 1916. These increased values in 1917 were due more to higher prices of farm produce than to increased production.

The average yields and farm values of the crops produced on the Belle Fourche project in 1917 are shown in Table II, the figures being obtained from the United States Reclamation Service.

TABLE II.—*Acreage, yields, and farm values of the crops produced on the Belle Fourche Reclamation Project in 1917.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Per acre.
				Average.	Maximum.			
Alfalfa hay	19,702	Ton	35,692	1.81	4.9	$15.00	$535,380	$27.20
Alfalfa seed	942	Bushel	2,335	2.5	11.0	8.00	18,680	19.80
Barley	2,286	do	55,164	24.2	78.0	1.25	68,955	30.00
Beans	217	do	1,155	5.3	43.0	6.00	6,930	31.90
Beets, sugar	1,771	Ton	10,502	5.9	20.0	6.50	68,263	38.35
Corn	2,902	Bushel	46,290	15.9	50.0	2.00	92,580	31.90
Corn fodder	1,166	Ton	1,918	1.6	10.0	8.00	15,344	13.20
Flax	870	Bushel	2,129	2.4	15.0	2.25	4,790	5.50
Garden vegetables, etc.	161						11,906	74.30
Hay, native	4,475	Ton	3,108	.7	2.9	16.00	49,728	11.10
Oats	4,955	Bushel	106,309	21.5	100.0	.70	74,416	15.00
Pasture, alfalfa	1,700						34,704	20.20
Pasture, other	4,400						32,000	7.28
Potatoes	285	Bushel	27,310	95.7	440.0	.90	24,579	86.40
Rye	76	do	1,500	19.8	25.0	1.70	2,550	33.50
Wheat	5,122	do	67,095	13.1	42.5	1.90	127,480	24.80
Miscellaneous	169						2,949	17.45
Less duplicated areas	1,173							
Total	50,026						1,171,239	
Average								23.50

TABLE III.—*Acreage, production, and farm values of the principal crops grown on the Belle Fourche Reclamation Project, 1913 to 1917, inclusive.*

Item and year.	All crops.	Alfalfa hay.	Alfalfa seed.	Barley.	Corn.	Hay, native.	Oats.	Pasture.	Wheat.
Acreage:									
1913	32,568	7,388	1,576	744	1,859	2,533	5,343	285	13,096
1914	36,709	9,745	1,416	1,448	4,415	2,236	6,392	3,604	7,885
1915	42,866	16,152	284	1,613	4,470	2,782	4,440	3,273	7,747
1916	46,909	17,945	4,177	2,740	3,846	2,121	4,119	6,132	7,554
1917	50,026	19,702	942	2,286	2,902	4,475	4,955	6,100	5,122
Production:		*Tons.*	*Bushels.*	*Bushels.*	*Bushels.*	*Tons.*	*Bushels.*		*Bushels.*
1913		15,854	2,157	18,801	35,615	2,232	161,765		195,205
1914		20,473	3,205	34,718	106,280	1,911	209,813		108,880
1915		34,842	65	47,365	64,098	2,507	165,260		133,248
1916		36,765	5,320	42,804	75,588	1,749	91,767		38,222
1917		35,692	2,335	55,164	46,290	3,108	106,309		67,095
Average yield per acre:									
1913		2.1	1.4	24.3	19.1	0.9	30.3		14.9
1914		2.1	2.3	24.0	24.1	.9	32.8		13.8
1915		2.2	.2	29.3	14.3	.9	37.3		17.2
1916		2.0	1.3	15.6	19.6	.8	22.1		5.1
1917		1.8	2.5	24.2	15.9	.7	21.5		13.1
Farm value per unit of yield:									
1913		$4.50	$6.00	$0.60	$0.80	$10.00	$0.40		$0.60
1914		4.50	7.30	.70	.70	10.00	.40		.90
1915		4.50	10.00	.65	.50	10.00	.40		.80
1916		7.00	8.00	.70	.80	9.50	.40		1.25
1917		15.00	8.00	1.25	2.00	16.00	.70		1.90
Farm value per acre:									
1913	$10.91	9.65	8.21	14.59	15.32	8.81	12.11	$6.98	8.94
1914	12.56	9.46	16.51	16.77	16.85	8.55	13.12	3.25	12.41
1915	10.80	9.90	2.00	19.05	7.15	9.00	14.92	4.32	13.76
1916	11.88	14.34	10.19	10.94	15.72	7.83	8.91	4.55	6.32
1917	23.50	27.20	19.80	30.00	31.90	11.10	15.00	7.28	24.80
Total farm values:									
1913	355,380	71,343	12,492	10,861	28,492	22,320	64,706	1,990	117,123
1914	461,188	92,129	23,397	24,303	74,396	19,110	83,925	12,078	97,992
1915	462,050	156,789	650	30,787	32,049	25,070	66,104	14,105	106,598
1916	557,342	257,355	42,560	29,963	60,470	16,615	36,707	27,826	47,778
1917	1,171,239	535,380	18,680	68,955	92,580	49,728	74,416	66,709	127,480

Table III shows the annual average production and farm values of the principal crops grown on the Belle Fourche project in the years 1913 to 1917, inclusive, based on data obtained from the United States Reclamation Service. The average yield per acre of all crops has remained rather low, owing chiefly to the fact that every year large areas of new land are broken up and planted. Much of this new land is poorly farmed and the yields secured are low, so that the average for the project is reduced. The farm value per acre and the total farm value of all crops in 1917 were practically twice those of 1916.

Table IV shows the live stock on hand January 1 and December 31, 1917, their value, and the increase in total value. These figures were obtained from the United States Reclamation Service.

TABLE IV.—*Inventory of live stock on the Belle Fourche Reclamation Project in 1917.*

Item.	Inventory, Jan. 1.			Inventory, Dec. 31.			Increased total value.
	Number.	Value.	Total value.	Number.	Value.	Total value.	
Horses	3,514	$88.83	$312,160	3,734	$91.18	$340,482	$28,322
Mules	86	104.30	8,970	88	108.24	9,505	535
Cattle:							
Beef	8,178	42.58	348,214	6,616	50.53	334,295	[a] 13,919
Dairy	2,870	56.92	163,355	2,912	60.65	176,618	13,263
Sheep	32,152	5.65	181,659	36,459	12.65	461,346	279,687
Hogs	13,631	8.48	115,613	10,946	15.10	165,240	49,627
Fowls	27,094	.47	12,648	24,028	.73	17,612	4,964
Bees, hives	541	5.34	2,888	541	5.34	2,888	.....
Total	.....	.....	1,145,507	.....	.....	1,507,986	362,479

[a] Decrease.

The total number of live stock on hand at the close of each year and their value as ascertained by the United States Reclamation Service for the years 1913 to 1917, inclusive, are shown in Table V.

The principal live-stock industries show a steady increase in importance each year, except that beef cattle show a decrease of 1,562 head in 1917 and hogs show a decrease in the total number in the same year. The average values per head for the different years are fairly uniform, except those of hogs and sheep, which more than doubled in 1917. The total value of all live stock on the project in 1916 was $1,145,507 and in 1917 $1,507,986, an increase of $362,479 in the year.

Table VI shows the number of carloads of cattle, sheep, hogs, and horses shipped from and received at the project towns during the years 1916 and 1917, according to figures obtained from the district freight office at Deadwood, S. Dak.

TABLE V.—*Inventory and value of live stock on hand on the Belle Fourche Reclamation Project at the close of each year for the 5-year period, 1913 to 1917, inclusive.*

Live stock.	1913	1914	1915	1916	1917
Number:					
Horses	2,490	2,848	3,135	3,514	3,734
Mules	89	59	65	86	88
Cattle:					
Beef	[a] 2,758	2,514	5,524	8,178	6,616
Dairy		1,578	2,200	2,870	2,912
Sheep	12,872	25,740	26,210	32,152	36,459
Hogs	4,636	11,988	14,798	13,631	10,946
Fowls	23,125	29,186	21,315	27,094	24,028
Bees, hives	139	129	326	541	541
Average value per head:					
Horses	$90.32	$87.50	$92.80	$88.83	$91.18
Mules	83.65	112.10	120.00	104.30	108.24
Cattle:					
Beef	[a] 46.14	46.50	47.60	42.58	50.53
Dairy		57.75	56.10	56.92	60.65
Sheep	3.76	3.76	4.48	5.65	12.65
Hogs	8.75	8.97	6.75	8.48	15.10
Fowls	.46	.49	.48	.47	.73
Bees, hives	5.76	6.20	7.45	5.34	5.34
Total value:					
Horses	224,891	249,150	290,875	312,160	340,482
Mules	7,445	6,635	7,805	8,970	9,505
Cattle:					
Beef	[a] 127,214	116,901	262,480	348,214	334,295
Dairy		91,129	123,195	163,355	176,618
Sheep	48,471	96,782	117,296	181,659	461,346
Hogs	40,576	107,772	99,640	115,613	165,240
Fowls	10,586	14,252	12,533	12,648	17,612
Bees, hives	801	801	2,429	2,888	2,888
Total	459,984	683,422	916,253	1,145,507	1,507,986

[a] Beef and dairy cattle for 1913 were not segregated.

TABLE VI.—*Carload lots of live stock shipped from and received at four shipping points on the Belle Fourche Reclamation Project in 1916 and 1917.*

Shipping point.	Forwarded.								Received.							
	Cattle.		Sheep.		Hogs.		Horses.		Cattle.		Sheep.		Hogs.		Horses.	
	1916	1917	1916	1917	1916	1917	1916	1917	1916	1917	1916	1917	1916	1917	1916	1917
Bellefourche	406	760	237	216	50	35	84	98	180	36	31	14	1	6	10	19
Fruitdale	28	72	10	35	19	13	2	7	20	.....	1	3	1	1	....	1
Nisland	28	92	12	39	43	29	2	1	14	7	14	5	....	1	....	....
Newell	162	233	118	131	81	77	11	5	85	57	72	53	....	....	3	....
Total	624	1,157	377	421	193	154	99	111	299	100	118	75	2	8	13	20
Increase	.....	533	.....	44	.....	.....	....	12	.....	.....	.....	.....	....	6	....	7
Decrease	.....	.....	.....	.....	.....	39	....	.....	.....	199	.....	43	....	....	....	....

The total number of carloads of all stock shipped out from the four project towns in 1917 was 1,843, an increase of 550 carloads over 1916. During the same period 203 cars were shipped in, showing a decrease of 229 cars as compared with 1916.

ROTATION EXPERIMENTS WITH IRRIGATED FIELD CROPS.

DESCRIPTION OF ROTATIONS.

In 1912 a series of crop-rotation experiments under irrigation was commenced. These rotations are listed below.

Continuous cropping.
- No. 1. Oats.
- No. 2. Beets.
- No. 3. Spring wheat.
- No. 4. Potatoes.
- No. 5. Winter wheat.
- No. 6. Corn.
- No. 7. Spring wheat (return straw).
- No. 8. Alfalfa.
- No. 9. Flax.

Two-year rotations:
- No. 16. Corn, oats.
- No. 18. Wheat, beets.
- No. 20. Potatoes, beets.
- No. 21. Potatoes, beets (manured).
- No. 22. Oats, beets.
- No. 23. Oats (manured), beets.
- No. 24. Potatoes, oats.
- No. 25. Potatoes, oats (manured).
- No. 26. Potatoes, corn.
- No. 27. Potatoes, oats. Seed rye on oat stubble in fall as early as possible and plow under in spring before planting potatoes.
- No. 28. Wheat, oats.

Three-year rotations:
- No. 30. Potatoes, oats, beets.
- No. 31. Potatoes, oats (manured), beets.
- No. 32. Corn, oats, beets.

Four-year rotations:
- No. 40. Potatoes, beets, alfalfa, alfalfa.
- No. 42. Oats, beets, alfalfa, alfalfa.
- No. 44. Potatoes, oats, alfalfa, alfalfa.
- No. 48. Wheat, oats, alfalfa, alfalfa.

Six-year rotations:
- No. 60. Potatoes, oats, beets, alfalfa, alfalfa, alfalfa.
- No. 61. Potatoes, oats (manured), beets, alfalfa, alfalfa, alfalfa.
- No. 62. Corn, oats, beets, alfalfa, alfalfa, alfalfa.
- No. 65. Corn (hogged), flax, oats, alfalfa, alfalfa, alfalfa (hogged).
- No. 66. Beets, flax, barley, corn, winter wheat, clover.

In 1913 two additional continuous-crop tests were started—No. 10 (barley) and No. 11 (clover). In 1914 rotations 1a to 9a, inclusive, were started as a duplication of rotations 1 to 9 to test continuous cropping. In 1915 rotation No. 69 was started. This is a 6-year rotation—corn two years, oats one year, and alfalfa three years. The third year the alfalfa is pastured by hogs, and both crops of corn are hogged off. In 1916 rotation No. 71 was started. This is a 6-year rotation—corn, beets, oats, and three years of alfalfa. The third year the alfalfa is pastured with ewes and their lambs, and the corn with lambs only. During five years of observations it appeared that beets after a cultivated crop did much better than following a grain crop, and that a stand of alfalfa could be secured at a much lower cost seeded with a nurse crop or fall seeded after the grain was removed than by seeding alfalfa without a nurse crop in the spring. A series of new rotations was started in 1917 to test these practices. These rotations are as follows:

Three-year rotations:
- No. 34. Potatoes, beets, oats.
- No. 35. Potatoes, beets, oats (manured).

Four-year rotation:

No. 46. Beets, oats, alfalfa, alfalfa.

Six-year rotation:

No. 64. Potatoes, beets, oats, alfalfa, alfalfa, alfalfa.

Rotations Nos. 34 and 35 have the same crops as Nos. 30 and 31, except that the beets follow potatoes instead of oats. Rotation No. 46 has the same crops as rotation No. 42, but the beets follow the alfalfa instead of the oats in No. 42 and the alfalfa is seeded after the oats have been harvested. Rotation No. 64 has the same crops as rotation No. 60, but beets follow the potatoes instead of oats and the alfalfa is seeded after the oats have been harvested.

The rotation experiments now contain 126 quarter-acre plats and include 10 crops, as shown in Table VII.

TABLE VII.—*Field crops grown in the 126 quarter-acre plats of the rotation experiments in progress on irrigated land on the Belle Fourche Experiment Farm in 1917.*

Crop.	Number of plats.	Crop.	Number of plats.
Oats	25	Corn	11
Beets	21	Flax	4
Spring wheat	7	Clover	2
Winter wheat	3	Barley	2
Potatoes	17		
Alfalfa	34	All crops	126

A view of a portion of the field used for these experiments is shown on the title-page.

CROP YIELDS.

Table VIII shows the maximum, minimum, and average yields per acre in the irrigated experiments on the Belle Fourche Experiment Farm in 1917 and a comparison of the average yields in the five previous years.

TABLE VIII.—*Yields of crops grown in the irrigated rotation experiments on the Belle Fourche Experiment Farm, 1912 to 1917, inclusive.*

Number of plats.	Crop.	Yield per acre, 1917.			Comparison of average yield per acre.				
		Maximum.	Minimum.	Average.	1912	1913	1914	1915	1916
26	Alfalfa hay.....tons..	4.75	0.70	3.0	.....	2.6	3.0	3.17	3.42
17	Sugar beets.....do....	20.86	6.52	12.35	7.6	7.8	11.6	9.2	7.6
7	Corn.....bushels..	53.80	22.72	42.92	28.7	34.0	43.6	27.6	39.5
3	Winter wheat.....do....	23.4	13.0	19.9	.....	11.3	22.9	27.1	11.9
7	Spring wheat.....do....	36.9	15.6	27.8	22.1	19.9	25.7	20.9	10.0
21	Oats.....do....	76.0	34.8	59.2	51.9	39.0	78.8	92.1	54.7
2	Barley.....do....	35.8	18.3	27.0	28.0	14.8	31.7	51.2	24.4
4	Flax.....do....	17.6	6.9	14.6	13.6	13.4	14.8	15.1	7.07
14	Potatoes.....do....	205.0	108.0	148.7	45.5	112.5	105.9	116.8	153.8
1	Clover hay[1].....tons..	.....	.....	.....	.....	.....	.44	1.18	.66
1	Clover seed.....do....	.....	.....	.....	.....	.....	.....	1.77	2.08

[1] Winterkilled in 1917.

Table VIII shows a wide difference in the yields obtained from the different plats. With the exception of alfalfa each crop was planted in the various plats at the same time with the same variety of seed and given similar cultural treatment, so the differences in yield result from the difference in soil and crop sequence and the application of manure. With the season of 1917 the experiment completes its sixth year. All the 6-year rotations started in 1912 completed their first cycle and the 2-year and 3-year rotations their second and third cycles. The average yield of alfalfa shown in Table VIII includes the yields of all alfalfa plats in the rotations. The maximum yield of alfalfa 2 or more years old was 4.75, the minimum 2.32, and the average 3.74 tons per acre.

The maximum yield of first-year alfalfa sown in the fall of 1916 was 3.93, the minimum 0.65, and the average 2.92 tons per acre. The maximum yield of first-year alfalfa planted in the spring of 1917 was 1.58, the minimum 0.70, and the average 1.08 tons per acre. There was an average difference of 1.84 tons per acre in favor of the fall-seeded alfalfa.

The yield of oats, potatoes, and beets in 1917 and the preceding crop in each case are shown in Table IX. The yields of each crop are averaged in order from the highest to the lowest, showing which preceding treatment gave the best results in 1917. It should be borne in mind that not all plats are on equally good soil and that differences in yield are due to soil variation as well as crop sequence.

TABLE IX.—*Yields per acre of oats, potatoes, and beets, showing the preceding crop in the irrigated rotations on the Belle Fourche Experiment Farm in 1917.*

[The application of manure wherever noted was made after the preceding crop mentioned was harvested.]

Oats.			Potatoes.			Beets.		
Preceding crop.	Rotation No.	Yield.	Preceding crop.	Rotation No.	Yield.	Preceding crop.	Rotation No.	Yield.
		Bushels.			*Bushels.*			*Tons.*
Beets	23	76.0	Beets	31	205.0	Oats (manured)	23	20.86
Potatoes	31	75.6	Potatoes	4a	192.7	Potatoes	21	18.50
Do	27	75.4	Beets (manured)	21	190.0	Oats (manured)	61	15.72
Do	25	74.4	Alfalfa	44	170.0	Potatoes	20	15.30
Flax	65	73.4	Corn	26	161.3	Oats (manured)	31	15.28
Potatoes	24	72.9	Potatoes	4	146.5	Potatoes	40	14.15
Do	44	71.9	Beets	30	139.0	Oats	60	12.68
Beets	22	71.5	Oats (manured)	25	134.7	Do	22	12.66
Wheat	48	69.4	Beets	20	132.7	Wheat	18	11.72
Potatoes	30	65.9	Alfalfa	61	130.4	Oats	42	10.00
Corn (hogged)	69	60.1	Oats (rye plowed under)	27	127.9	Beets	2a	9.08
Corn (sheeped)	71	60.0				Oats	62	8.54
Oats	1a	57.3	Alfalfa	40	124.0	Beets	2	8.22
Potatoes	60	51.8	Oats	24	120.2	Oats	32	7.58
Do	61	49.0	Alfalfa	60	108.0	Do	30	7.38
Corn	62	45.2				Clover	66	6.52
Do	16	42.3						
Do	32	41.4						
Wheat	28	40.4						
Alfalfa	42	35.5						
Oats	1	34.8						
Average of all plats		59.6			148.7			12.13

The maximum yield of sugar beets was 20.86, the minimum 6.52, and the average 12.13 tons per acre. The maximum yield was obtained in a 2-year rotation, oats (manured) followed by beets. This is the first year that this rotation has shown any decided effect from the application of manure. It yielded 8.2 tons per acre more than a similar rotation where no manure had been used. The lowest yield was obtained in a 6-year rotation in which beets follow clover. This rotation has given low yields every year except the first. The average sugar content of the beets grown in the rotation experiments for the six years from 1912 to 1917, inclusive, was 14.8, 19.1, 22.1, 17.7, 19.1, and 20.2 per cent, respectively. The sugar-beet results in 1917 were the most satisfactory since the experiment was commenced, especially as to yield of beets. The best yields have always been obtained where the beets followed a cultivated crop and manure. Beets following a grain crop without manure have given uniformly poor results. The sugar content for 1917 was above the average for the six years. The analyses of 22 samples showed that the maximum percentage of sugar was 22, the minimum 17.9, and the average 20.2. The maximum percentage of purity was 90.7, the minimum 83.6, and the average 87.2. In rotation 23, which produced the maximum yield of 20.86 tons per acre, the percentage of sugar was 19.9, and the purity 88.2 per cent.

The maximum yield of potatoes was 205, the minimum 108, and the average 148.7 bushels per acre. The highest yield was obtained in a 3-year rotation of potatoes, oats (manured), and beets, and the lowest was in a 6-year rotation of potatoes, oats, beets, and three years of alfalfa, the potatoes following the alfalfa. The most noticeable feature about the potato yields in 1917 was the high yields on the continuously cropped plats. In rotations 1 and 1a, potatoes cropped continuously for six and five years, the yields were 146.5 and 192.7 bushels, respectively. There also was a considerable increase in yields with all rotations containing manure. The yields after alfalfa were low, as in previous years. The results with potatoes in 1917 were the best obtained since the experiment was commenced. The average yield was 34.8 bushels above the average for the six years, and the average percentage of marketable tubers was 84.4.

The maximum yield of oats was 76, the minimum 34.8, and the average 59.6 bushels per acre. The maximum yield was obtained in a 2-year rotation of oats (manured) followed by beets, and the minimum on a continuously cropped plat. Oats after beets and potatoes have given uniformly good results, while after corn the yields have not been so satisfactory. So far, rotations with manure have not shown a decided increase in the yield of oats. In two comparable rotations, Nos. 22 and 23, the difference in favor of the manured rotation was only 4.5 bushels per acre in 1917.

The maximum yield of wheat was 36.9, the minimum 16.5, and the average 27.4 bushels per acre. The maximum yield was obtained in a 4-year rotation, No. 48, where wheat follows alfalfa. This rotation has been one of the highest yielding every year. The minimum yield was obtained from the continuously cropped plat. Wheat after beets has given good results every year.

Corn yields in 1917 were very satisfactory. The highest yield was 53.8, the minimum 22.72, and the average 42.92 bushels per acre. The highest yield was obtained from rotation No. 66, corn following barley, and the lowest yield was on the continuously cropped corn plat.

The maximum yield of flax was 17.6 bushels, the minimum 6.9, and the average 14.6 bushels per acre. The highest yield was obtained in rotation No. 9a and the lowest yield in rotation No. 9, both being continuous flax for six years, but plat No. 9 is on very poor ground and the yield has been uniformly low every year. Flax after corn (hogged), rotation No. 65, and after beets, rotation No. 66, has given uniformly good results, and the average for the six years is 16.1 and 15.5 bushels per acre, respectively.

From the six years of observations the more important indications have been as follows: Alfalfa has shown no marked increase in yield on crops that followed it. Grains following a cultivated crop have given better net returns per acre than when following alfalfa or grain. The application of manure has shown a marked increase in the yields of potatoes and sugar beets, but not of grains. Sugar beets following a cultivated crop have given uniformly good results, and sugar beets following a grain crop without any manure and after clover have given uniformly poor results. Alfalfa seeded shortly after the grain has been removed in the late summer has given the most satisfactory stand and produced higher yields the first year after planting. Early-seeded spring grains have given much better results as to both quality and yield than late-seeded spring grains.

PASTURING ALFALFA WITH HOGS.

In the 6-year rotation (No. 65), including alfalfa three years and corn, flax, and oats each one year, the third-year alfalfa is pastured with hogs until the corn is ripe and then the hogs are turned in to harvest the corn. In 1915 another 6-year rotation (No. 69) was added, consisting of three years of alfalfa, two years of corn, and one of oats. The third-year alfalfa is to be pastured each year and the corn is to be hogged. The hogs while on alfalfa pasture are fed a daily ration of 2 pounds of corn for each 100 pounds of live weight. Each of the third-year alfalfa plats was divided into two parts, to be pastured alternately. On May 28 four fall pigs, averaging 115 pounds in weight, were turned in to pasture the third-

year alfalfa in each rotation, and they remained until July 11, when they were taken off. Another lot of seven pigs, averaging 42 pounds, were pastured on each plat from July 12 until September 25. The average live weight for the season was 1,956 pounds per acre. The total gains made by the hogs for the period of 119 days averaged 535.5 pounds for each of the two quarter-acre plats, or 2,142 pounds per acre. During the pasturing season the hogs on the quarter-acre plat were fed 1,126 pounds of shelled corn in rotation No. 65 and 1,116 pounds in rotation No. 69. It took 2.64 pounds of corn to make a pound of gain in rotation No. 65 and 2.56 pounds in rotation No. 69.

The results of pasturing alfalfa on rotation No. 65 for five years and on rotation No. 69 for three years are shown in Table X.

TABLE X.—*Results of pasturing alfalfa with hogs on the Belle Fourche Experiment Farm, 1913 to 1917, inclusive.*

Year.	Rotation No.	Time on pasture.	Average live weight per acre	Grain fed per acre.	Gains made per acre.	Grain fed per pound of gain.
		Days.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1913	65	94	1,808	4,292	1,068	[a] 4.01
1914	65	121	1,815	5,104	1,830	2.79
1915	65	132	2,002	4,787	2,024	2.36
1915	69	132	2,060	4,976	2,108	2.36
1916	65	119	2,256	5,290	1,962	2.70
1916	69	119	2,238	5,128	2,006	2.56
1917	65	119	1,956	4,504	1,742	2.64
1917	69	119	1,956	4,464	1,740	2.56
Average for rotation No. 65, five years		117	1,973	4,795	1,725	2.91
Average for rotation No. 69, three years		123	2,084	4,856	1,951	2.49

[a] A ration of equal parts of ground oats, wheat, and barley was fed in 1913.

While pasturing hogs on alfalfa, the pastures have been divided into two lots and the hogs changed from one to the other every 10 days or two weeks. Frequent irrigations were also given, and the hogs were not allowed on the pasture while the soil was wet.

HOGGING CORN.

On September 25 three hogs, with an average initial weight of 108 pounds, were turned on the quarter-acre corn plat in rotation No. 65 and four hogs, with an average initial weight of 109 pounds, on the two quarter-acre plats in rotation No. 69. After 14 days one more hog of the same weight was put in rotation No. 65 and two more in rotation No. 69. The hogs were pastured for 30 days in rotation No. 65 and 37 days in rotation No. 69. During this time a total gain of 170.5 pounds was made on the quarter acre of corn in rotation No. 65, or at the rate of 682 pounds per acre. In rotation No. 69 a total gain of 268.5 pounds was made on the half acre, or at the rate of 537 pounds per acre. Careful estimates made of the corn

indicated a yield of 67.4 bushels per acre for rotation No. 65 and 55.4 bushels for rotation No. 69. On this basis it took 5.5 pounds of corn to make a pound of gain in rotation No. 65 and 5.7 pounds in rotation No. 69. The hogs made an average daily gain of 1.60 pounds in rotation No. 65 and 1.38 pounds in rotation No. 69. Table XI shows the results of hogging for six years in rotation No. 65 and three years in rotation No. 69.

TABLE XI.—*Results of harvesting corn with hogs on the Belle Fourche Experiment Farm, 1912 to 1917, inclusive.*

Year.	Rotation No.	Length of test.	Live weight per acre when turned on corn.	Gains per acre.	Estimated corn yield per acre.	Corn fed per pound of gain.	Average initial weight.	Average daily gain per hog.
		Days.	*Pounds.*	*Pounds.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*
1912	65	26	680	340	28.7	4.7	85	1.63
1913	65	11	1,632	560	34 0	3.4	51	1.59
1914	65	20	1,708	582	34.8	3.3	106	1.81
1915	65	15	1,620	548	40.6	4.2	81	1.85
	69	10	1,780	451	34.0	4.2	89	1.87
1916	65	24	1,252	518	59.1	5.9	104	1.80
	69	26	1,268	456	47.7	5.8	105	1.53
1917	65	30	1,280	682	67.4	5.5	108	1.60
	69	37	1,206	537	55.4	5.7	109	1.38
Average for rotation No. 65, six years		21	1,362	538	46.1	4.7	89	1.71
Average for rotation No. 69, three years		24	1,418	481	44.2	5.1	101	1.64

At the completion of this experiment in the fall of 1917 the hogs were sold at Newell for 15 cents a pound. At this rate the gains made in rotation No. 65 would be $102.30 and in rotation No. 69 $80.55 per acre.

HARVESTING ALFALFA, CORN, AND BEET TOPS WITH SHEEP.

The possibility of using sheep to harvest crops grown under irrigation was taken up in a new rotation, No. 71, in the spring of 1916. This is a 6-year rotation of corn, beets, and oats, each one year, followed by alfalfa for three years. The third-year alfalfa is pastured with ewes and their lambs. As soon as the beets are harvested the lambs have access to the beet tops also. The third-year alfalfa plat in rotation No. 71 was fenced into two lots, and two ewes and their lambs were turned in on May 24. The total live weight for the quarter-acre plat was 388 pounds. The average weight of the two ewes was 124 pounds and that of the four lambs 35 pounds. The alfalfa did not make sufficient growth to support all these sheep for the season, and they were kept off the plat from June 15 to June 29 and from July 13 to July 21. At the last-mentioned date the lambs were weaned. When the alfalfa was large enough to be pastured again six lambs were turned in instead of the ewes and their lambs.

This pasturing period was from August 18 to September 4. The total gain for the quarter-acre plat from May 24 to September 4 on alfalfa alone was 139 pounds, or 556 pounds per acre. On September 4 the corn was just beginning to ripen, and twelve lambs, with an average initial weight of 72 pounds, were turned in to harvest the corn. After two weeks, four of these lambs were removed in order to lengthen the pasturing period. The lambs had access to the alfalfa pasture also while on the corn, but very little pasture was furnished from the alfalfa after September 4. On October 6 the lambs were also given access to the beet tops. The experiment ended October 16, making a total pasturing period of 42 days for the corn and beet tops. The total gain made on the quarter acre of corn, an equal area of beet tops, and what little was used of alfalfa pasture was 181 pounds, or at the rate of 724 pounds per acre of corn, supplemented with an acre of beet tops and access to alfalfa pasture. The estimated yield of corn on this plat was 57 bushels per acre. From the observations made in 1916 and 1917 it appears that lambs will produce fully as good gains as hogs when used for harvesting corn in the field, and they appear to be able to clean up the field more thoroughly than hogs. Lambs can be turned into a cornfield two or three weeks before the corn is ripe and during this time will clean up the weeds, the lower leaves of the corn, and even the husks before they finally eat the corn itself.

Harvesting alfalfa and corn with hogs or sheep seems to be a most desirable practice. On the heavy gumbo soils, alfalfa alone has not shown any beneficial effect on the crops that follow. In rotations Nos. 65 and 69, where the alfalfa has been pastured with hogs, the yields of corn following alfalfa have been materially increased. The yield in 1917 was more than double what it was in 1912, when the rotation was started. Similar benefits are beginning to be apparent in rotation No. 71, in which corn is harvested by sheep. The saving of labor and the improvement in the soil are important points in favor of harvesting certain farm crops by pasturing with sheep or hogs.

Sheep, pasturing on a plat of alfalfa, are shown in figure 2.

PASTURING SHEEP ON ALFALFA.

Because of the danger from bloat there is generally a prejudice against pasturing sheep on alfalfa. However, several farmers on the Belle Fourche project have been using alfalfa for sheep pasture, some during the entire season and others for short periods in the fall. Some farmers had no losses, while others report a few, but all agree that they have no more losses than are likely to occur from other causes than bloat. In order to determine the carrying capacity of alfalfa for sheep, the gains per acre, and the probable losses from

bloat, some tests in which sheep have been pastured on alfalfa have been conducted for the last three seasons in addition to those carried on in the rotation experiments. In 1915, 10 lambs, with an average initial weight of 75 pounds, were turned into an acre of third-cutting alfalfa on August 28 and pastured for 40 days. During that time they made a gain of 155 pounds and an average of 0.39 pounds per day each. In 1916 the same 10 sheep were pastured for the entire season, 120 days. The total weight of the 10 sheep when turned into the field was 1,419 pounds, and at the close of the period 1,656 pounds, a total gain of 266.5 pounds. These animals had good care during the winter, so that they were very nearly full grown and could not be expected to make much gain. In the spring of 1917, 1½ acres of

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FIG. 2.—Sheep on alfalfa at the Belle Fourche Experiment Farm. The saving of labor and the improvement of the soil are important points favoring this method of utilizing alfalfa and certain other irrigated field crops.

established alfalfa were fenced into three lots of one-half acre each. On May 24 nine ewes 2 to 6 years old and four ewes each with twin lambs were started on the pasture. The sheep had good pasture up to August 29, but at this time the alfalfa on all three plats was grazed down rather short, so they were taken off until September 7, after which they were pastured again until October 5. The old ewes made a gain for the season of 258 pounds and the lambs gained 244 pounds. The lambs while on the alfalfa pasture made an average daily gain of 0.32 pound per day. Figuring the carrying capacity on an acre basis, the results for 1917 would be eight ewes, averaging 130 pounds, and four lambs, averaging 57 pounds, for a pasturing period of 130 days. At no time during the pasturing period was there any trouble with bloat or any other ill effects from pasturing alfalfa either in

1917 or in the previous two years. The results obtained indicate that if an alfalfa pasture is divided into two lots for alternate pasturing and is well irrigated, the carrying capacity with sheep should be about 1,300 to 1,400 pounds per acre.

The alfalfa pastured in 1916 was cut for hay in 1917, but all three cuttings were poor and produced only half as much hay as similar alfalfa that had not been pastured. While pasturing alfalfa with sheep has a very beneficial effect on crops which follow, it is injurious to the alfalfa stand, so that such pasturing should be done on alfalfa that is to be plowed up before the beginning of the following crop season.

PASTURING HOGS ON ALFALFA SUPPLEMENTED WITH VARIOUS GRAIN RATIONS.

In the spring of 1917 some investigational work in swine production was inaugurated in cooperation with the Animal Husbandry Division of the Bureau of Animal Industry.[1] These experiments include comparisons of various grains as supplements to alfalfa pasture, the cost of carrying brood sows through the summer, the dry-lot feeding of swine, and the hogging of corn. The results of the first year of the experiments in pasturing alfalfa, supplemented with various grain rations, are here summarized. The results of the other experiments are not yet ready for publication. The alfalfa pasturing experiments were conducted in fields A and K on duplicate quarter-acre plats, and each of these plats was divided into two parts. Eight lots of hogs were used. Two lots received no grain, two lots were fed a 2 per cent ration of barley, two lots a 2 per cent ration of shorts, and two lots a 2 per cent ration of corn. The pasturing was begun on May 28 and continued until July 11, a period of 44 days. The hogs used during this period were good grades of the Duroc-Jersey breed, averaging in weight about 115 pounds.

Table XII summarizes the results obtained during this period.

TABLE XII.—*Results of pasturing fall pigs on alfalfa supplemented by various grain rations for 44 days, from May 28 to July 11, on the Belle Fourche Experiment Farm in 1917.*

Items of comparison.	No grain.	2 per cent supplemental ration.		
		Barley.	Shorts.	Corn.
Number of pigs per acre	12	16	16	16
Average initial weight.....pounds..	126	114.5	114.5	115.0
Average final weight.....do....	136.5	159.5	162.5	157.5
Average carrying capacity per acre.....do....	1,576	2,198	2,222	2,178
Total gain per acre.....do....	128.0	717	779	674
Gain per acre per day.....do....	2.75	16.29	17.7	15.31
Average gain per pig per day.....do....	.24	1.01	1.10	.95
Grain fed per pound of gain.....do....	.....	2.69	2.47	2.79

[1] This work was under the immediate supervision of Mr. S. H. Bober, who has been assigned to these investigations by the Bureau of Animal Industry, U. S. Department of Agriculture.

On July 12 the lots that were fed a 2 per cent grain ration were replaced by spring pigs averaging 42 pounds each. The lot receiving no grain was continued for the remainder of the season. This pasturing period was continued for 75 days, closing on September 25.

Table XIII summarizes the results obtained with spring pigs for this period and with the fall pigs receiving no grain.

TABLE XIII.—*Results of pasturing pigs on alfalfa supplemented by various grain rations for 75 days, from July 12 to September 25, on the Belle Fourche Experiment Farm in 1917.*

Items of comparison.	No grain.	2 per cent supplemental ration.		
		Barley.	Shorts.	Corn.
Number of pigs per acre	8	28	28	28
Average initial weight....pounds..	118.8	42	42	42
Average final weight....do....	117.5	80.5	82.5	80.5
Average carrying capacity per acre....do....	944	1,724	1,752	1,712
Total gain per acre....do....	—10.8	1,068	1,124	1,067
Gain per acre per day....do....	— .14	14.25	15.0	14.24
Average gain per pig per day....do....	— .02	.50	.53	.50
Grain fed per pound of gain....do....		2.45	2.33	2.45

Table XIV presents a summary of the results obtained during the entire pasturing season in 1917.

TABLE XIV.—*Results of pasturing fall and spring pigs on alfalfa supplemented by various grain rations between May 28 and September 25 on the Belle Fourche Experiment Farm in 1917.*

Items of comparison.	No grain.	2 per cent supplemental ration.		
		Barley.	Shorts.	Corn.
Time on pasture....days..	115	119	119	119
Average carrying capacity per acre....pounds..	1,305	1,961	1,987	1,945
Total gain per acre....do....	117	1,785	1,803	1,741
Total grain fed per acre....do....		4,552	4,552	4,504
Pounds of grain per pound of gain....do....		2.55	2.39	2.39

These experiments were conducted on alfalfa established three or more years ago on duplicate quarter-acre plats, each divided into two parts. The hogs were changed from one part to the other about every 10 days or 2 weeks. The plats were irrigated frequently, and the hogs were not allowed on the pasture while the soil was wet.

From the results obtained it appears that a pound of shorts or ground barley is as good as a pound of corn as a supplemental feed for hogs on alfalfa pasture. Which of these feeds to use will depend largely on the market prices. The average local prices per pound at Newell in the summer of 1917 were as follows: Barley, 3 cents; shorts, 2.25 cents; corn, 4 cents. Using these prices, it cost 7.65 cents to produce 1 pound of pork on a 2 per cent ration of barley; 5.37 cents

on a 2 per cent ration of shorts, and 10.32 cents on a 2 per cent ration of corn. The outstanding feature of the 1917 results is the greatly increased gain per acre obtained where a grain ration was used, as compared with the gains on alfalfa alone.

PASTURE GRASSES.

The economical feeding of dairy stock on the reclamation projects involves the use of grass pastures. These irrigated pastures are of a permanent nature, and while the first cost of establishing them is somewhat high the subsequent cost of care is not great. For maximum results the pasture should be located on the best available ground, not only as to fertility but also as to ease of irrigation.

TESTS WITH COWS.

The following pasture mixtures were seeded at the experiment farm in 1915 and pastured with two cows in 1916 and 1917:

Mixture A.—Timothy, 4 pounds; Italian rye-grass, 2 pounds; orchard grass, 6 pounds; brome-grass, 2 pounds; redtop, 4 pounds; Kentucky bluegrass, 4 pounds; perennial rye-grass, 2 pounds; meadow fescue, 2 pounds; tall fescue, 2 pounds; western wheat-grass, 2 pounds; tall oat-grass, 2 pounds. Total, 32 pounds per acre.

Mixture B.—The same as mixture A except that 2 pounds per acre of white clover and 2 pounds per acre of alsike clover were added.

Mixture C.—The same as mixture B, except that 2 pounds of alfalfa per acre were added.

Mixture D.—Brome-grass, 20 pounds; slender wheat-grass, 12 pounds; alfalfa, 3 pounds. Total, 35 pounds per acre.

Mixtures A, B, and C were sown on quarter-acre plats, while 1 acre was sown to mixture D. These plats were top-dressed lightly with well-rotted manure early in the spring of 1916. All plats were given frequent irrigation, the aim being to keep the surface soil well supplied with moisture.

Table XV shows the pounds of milk and butter fat and the number of days of pasture for one cow per acre in 1916 and 1917 on the plats seeded to these four mixtures.

A view of one of the plats and of the cows used is shown in figure 3.

TABLE XV.—*Results of pasturing two cows with four pasture mixtures on the Belle Fourche Experiment Farm in 1916 and 1917.*

Mixture.	Production per acre (pounds).						Pasture per cow per acre (days).		
	Milk.			Butter fat.					
	1916	1917	Average.	1916	1917	Average.	1916	1917	Average.
A	3,124	2,462	2,793	124.1	110.7	117.0	136	64	100
B	2,512	2,888	2,700	94.4	129.9	111.9	112	64	88
C	3,656	3,401	3,528	144.5	153.0	148.7	160	80	120
D	2,598	3,459	3,028	105.1	137.6	121.3	180	140	160

Mixture D afforded pasture for the largest number of days in 1916 and 1917, but some difficulty was encountered with bloat in using this mixture. The differences in butter-fat and milk production indicated in Table XV were probably due less to the grass mixtures than to the stages of lactation of the cows in the two seasons. It appears that the number of days that pasture was afforded is a more reliable measure in this instance than the production of the cows.

TESTS WITH HEIFERS.

In order to determine whether mixtures less elaborate than those known as A, B, and C would prove satisfactory, a new series of plats was sown in 1916. It has been determined already, from previous

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FIG. 3.—Dairy cows in a pasture test on the Belle Fourche Experiment Farm. The economical feeding of dairy stock on the reclamation projects involves the use of grass pastures.

seeding, that Italian rye-grass should be eliminated, as it produces too rank a growth the first season, crowds out the other grasses in the mixture, and the later growth is less vigorous.

The seeding made in 1916 includes the mixtures at the rates per acre shown in Table XVI.

The pasturing of the mixtures planted in 1916 was first commenced on May 29, 1917. No milk cows were available, so five grade Holstein heifers, from 6 to 12 months old, with an average initial weight of 380 pounds, were used. The results are shown in Table XVII.

There was very little difference in the number of days of pasturing and the total live weight carried per acre in mixtures 1 to 3, inclusive, while the carrying capacity of mixture No. 4 was very nearly three times as great as the other mixtures. The total gains made per acre

with mixture No. 4 were as good as with any other mixture, but the average daily gain was less. This is the first year that any of these mixtures have been pastured. The stands in mixtures 1 to 3, inclusive, were very much improved by fall, and the grasses seemed better established. The sweet clover did not go to seed, and it may be that this mixture will do as well next season. The stock seemed to eat the sweet clover as well as any of the other grasses, and this year there was no trouble with bloat.

TABLE XVI.—*Rates of seeding per acre of mixtures of grass seed for pasture on the Belle Fourche Experiment Farm in 1916.*

Kinds of seed.	Seed per acre (pounds).			
	Mixture 1.	Mixture 2.	Mixture 3.	Mixture 4.
Kentucky bluegrass	3	5		
Brome-grass	4		6	6
Meadow fescue	6	10		
Orchard grass	5			
Tall oat-grass	6		10	6
White clover	2	2	2	
Sweet clover				6
Total	26	17	18	18

TABLE XVII.—*Results of pasturing five heifers on four pasture mixtures on the Belle Fourche Experiment Farm in 1917.*

Mixture.	Area (acres).	Pasture afforded (days).		Gain per acre (pounds).
		Per heifer.	Per acre.	
No. 1	0.50	89	178	340
No. 2	.50	103	206	500
No. 3	.50	88	176	400
No. 4	.25	127	508	500

SUGGESTIONS ON STARTING PASTURES.

Several methods might be employed in securing a stand of pasture grasses. Good results have been obtained by seeding with a nurse crop of oats or barley and keeping this clipped during the summer. The grain starts more quickly than any of the grasses, so that the land can be irrigated without washing the soil. Good stands have also been obtained where the grain has been allowed to ripen, but in this case special care must be given to the irrigation, attention being paid to the needs of the grasses rather than those of the grain. Good stands have also been obtained by seeding the grasses in the stubble after the grain is harvested and by irrigating immediately after planting. Where grasses are seeded with a nurse crop for grain or in the stubble after the grain is removed, the next season's growth is rather slow, and very little pasturing can be done the first part of the season. No complete recommendations can yet be made

as to the mixture, but the indications are that some of the simple mixtures do fully as well as the more elaborate combinations. Bromegrass, meadow fescue, bluegrass, tall oat-grass, and white clover are suggested as a mixture well worth trying. Mixtures containing alfalfa even in small quantities can not be recommended, as there is always danger of bloat wherever alfalfa is present.

SMALL-GRAIN VARIETAL EXPERIMENTS.[1]

WINTER WHEAT, RYE, EMMER, AND SPELT.

Owing to dry, cool weather in the autumn of 1916 and extreme cold during the following winter, the season of 1917 was rather unfavorable for winter grain. Emmer and spelt failed completely, owing to winterkilling. About one-third of the wheat was destroyed, but this was partly in spots which were accidentally flooded late in the fall. The wheat and rye were sown in triplicated fiftieth-acre plats on potato ground which was disked, irrigated, and harrowed previous to seeding. The wheat was seeded at the rate of 4 pecks and the rye at 5 pecks per acre. Single plats of emmer and spelt were sown along with the wheat and rye for comparison. All the winter grains were irrigated three times. The Turkey selection has produced the highest yield of grain during each of the past three years, with the Kharkof (C. I. No. 1583) yielding slightly less. Winter wheat has outyielded winter rye. Emmer and spelt are not sufficiently hardy for this region. The yields are shown in Table XVIII.

TABLE XVIII.—*Annual and average yields of varieties of winter wheat, rye, emmer, and spelt grown on the Belle Fourche Experiment Farm in 1915, 1916, and 1917.*

Crop, group, and variety.	C. I. No.[a]	Yield per acre (bushels).			
		1915	1916	1917	3-year average.
WHEAT.					
Crimean:					
Kharkof	1583	66.3	11.3	29.5	35.7
Do	4207	61.3	.....	.....	.....
Turkey	3055	.....	8.7	26.7	.....
Turkey selection	3055–159	66.6	11.5	31.0	36.3
Beloglina	1667	[b] 52.1	8.7	30.7	30.5
Ghirka Winter:					
Ghirka	1438	.....	8.8	19.9	.....
Ghirka Winter selection	5238	57.5	.....	.....	.....
Do	1437–394	51.9	.....	.....	.....
Do	5297	59.1	5.2	28.5	30.9
RYE.					
Swedish (Minn. No. 2)	137	44.6	10.8	21.3	25.5
North Dakota No. 959	175	[b] 38.8	11.7	25.4	25.3
EMMER.					
Buffum Black Winter	3331	.....	[b] 13.2	.....	.....
SPELT.					
Beardless Brown Winter	.....	.....	[b] 7.8	.....	.....

[a] Cereal Investigations number. [b] One plat only.

[1] These experiments are conducted in cooperation with the Office of Cereal Investigations of the Bureau of Plant Industry, United States Department of Agriculture, under the supervision of Mr. J. H. Martin, who prepared this report.

SPRING WHEAT.

Five varieties of spring wheat were sown on disked corn ground in triplicated fiftieth-acre plats at the rate of 5 pecks per acre. The wheat was irrigated three times. The yields of the Marquis and Kubanka varieties were reduced on account of thin stands. The growth of the Marquis wheat was not very vigorous in 1917. The Kubanka, a durum variety, has given the highest average yield during a period of years. Of the common wheats the Marquis appears to be the best variety. The yields of the spring-wheat varieties are shown in Table XIX.

TABLE XIX.—*Annual and average yields of varieties of spring wheat grown on the Belle Fourche Experiment Farm in the 6-year period, 1912 to 1917, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).							
		1912	1913	1914	1915	1916	1917	Average.	
								1912 to 1917.	1913 to 1917.
DURUM.									
Kubanka	1440	20.8	18.6	22.8	22.0	20.6	25.2	21.6	21.8
COMMON.									
Fife:									
Power	3025	19.5	17.0	17.0	14.7	8.4	27.3	17.3	16.9
Saskatchewan	.....	.....	.....	14.9	12.1	.....	.....	.....	.....
Marquis	3276	.....	18.3	18.3	18.0	9.4	20.1	.....	16.8
Ghirka Spring	1517	16.4	.....	.....	.....	.....	.....	.....	.....
Bluestem: Haynes	2874	22.0	14.2	15.4	11.5	7.3	19.8	15.0	13.6
Preston: Pringle Champlain	4782	.....	.....	19.0	12.2	6.5	29.5	.....	.....
Miscellaneous: Defiance	3703	.....	11.7	18.0	8.0	2.0	.....	.....	.....

TABLE XX.—*Annual and average yields of oat varieties grown on the Belle Fourche Experiment Farm in the 6-year period, 1912 to 1916, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).							
		1912	1913	1914	1915	1916	1917	Average.	
								1912 to 1917.	1915 to 1917.
Early:									
Sixty Day	165	[a] 25.0	47.1	32.5	34.0	28.8	51.5	36.5	38.1
Kherson	459	[a] 30.4	.....	.....	.....	.....	.....	.....	.....
Albion (Iowa No. 103)	729	.....	.....	.....	.....	20.2	.....	.....	.....
Richland (Iowa No. 105)	787	.....	.....	.....	.....	18.1	.....	.....	.....
Midseason:									
Swedish Select	134	[a] 35.2	33.0	41.6	46.5	36.9	54.6	41.3	46.0
Canadian	444	31.2	39.3	42.4	44.7	25.9	65.8	41.5	45.5
Lincoln	781	.....	.....	.....	50.7	36.1	52.8	.....	46.5
Silvermine	782	.....	.....	.....	52.3	41.6	61.1	.....	51.6
Peter Edwards [b]	778	.....	.....	[a] 50.7	51.8	37.4	57.8	.....	49.0
Great Dane	.....	.....	.....	[a] 32.8	.....	.....	.....	.....	.....
Abundance	780	.....	.....	.....	.....	35.3	57.0	.....	.....
Danish	.....	.....	.....	.....	.....	34.8	.....	.....	.....
Late:									
Mammoth Cluster	770	.....	.....	[a] 43.7	.....	24.7	.....	.....	.....
White Russian	551	[a] 41.4	33.7	48.6	52.8	42.1	56.2	45.8	50.3
White Tartarian	300	[a] 46.8	.....	.....	.....	.....	.....	.....	.....

[a] One plat only.
[b] Obtained from a farmer named Edwards, living in the vicinity of the experiment farm; similar to Swedish Select.

OATS.

The oat varieties in 1917 were seeded on disked corn ground in triplicated fiftieth-acre plats at the rate of 10 pecks per acre. The crop was irrigated three times. The yields of all varieties were fairly good. The highest yielding variety this year was the Canadian. The White Russian, a very late side oat, has the highest average yield in the last six years. The Silvermine is one of the most promising of the midseason varieties of oats. Early varieties, such as the Sixty Day, are not very productive under irrigation on the Belle Fourche farm. The yields of the oat varieties during the last six years are shown in Table XX.

BARLEY AND SPRING EMMER.

Seven varieties of barley were seeded on disked corn ground in triplicated fiftieth-acre plats at the rate of 6 pecks per acre. Three plats of White Spring emmer were sown for comparison with barley on an adjoining series at the rate of 8 pecks per acre. All plats received three irrigations. The 2-rowed varieties Hannchen and Chevalier outyielded all of the 6-rowed types of barley. These varieties have also produced well during the last six years and are recommended for growing under irrigation in this section. The yields of the hull-less varieties were somewhat reduced on account of thin stands. The yields of emmer in pounds of grain per acre have been somewhat less than those of the better varieties of barley. The annual yields from 1912 to 1917, inclusive, with the average for the last four years, are shown in Table XXI.

TABLE XXI.—*Annual and average yields of varieties of barley and spring emmer on the Belle Fourche Experiment Farm in the 6-year period, 1912 to 1917, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).						
		1912	1913	1914	1915	1916	1917	Average, 1914 to 1917.
Six-rowed hulled:								
Coast	690	.....	.....	.....	23.0	15.2	37.9	.....
Manchuria (Wis. No. 13)	905	.....	25.8	21.8	20.9	14.7	23.9	20.3
Manchuria (Minn. No. 6)	638	16.9	.....	.....	.....	.....	.....	.....
Manchuria (Minn. No. 105)	354	.....	23.5	17.8	.....	.....	.....	.....
Odessa	182	17.4	.....	.....	.....	.....	.....	.....
Trebi	936	.....	.....	.....	.....	.....	38.0	.....
Two-rowed hulled:								
Chevalier	1,142	.....	.....	26.8	37.2	23.2	.....	.....
Chevalier II	530	13.0	.....	23.0	39.2	23.9	38.5	31.1
Hannchen	531	19.8	32.9	15.0	.....	25.1	40.7	.....
Six-rowed naked:								
Himalaya (Guy Mayle, awned)	620	.....	.....	26.6	23.4	17.5	23.7	22.8
Nepal (white hull-less, hooded)	595	9.1	.....	19.2	20.4	14.9	22.3	19.2
Emmer:								
White Spring[1]	1,524	24.5	27.8	34.0	58.0	35.6	57.7	46.3

[1] Yields of emmer are computed at 32 pounds per bushel.

FLAX.

The flax varieties in 1917 were seeded on disked corn ground in triplicated fiftieth-acre plats at the rate of 30 pounds per acre. The flax received three irrigations. Ripening was slightly delayed by a secondary blooming period, which was partly caused by overirrigation. The highest yielding variety in 1917 was the Damont (C. I. No. 3). This variety and the Russian (C. I. No. 19) have proved to be the most satisfactory in this district. The annual and average yields for the six years, 1912 to 1917, inclusive, are shown in Table XXII.

TABLE XXII.—*Annual and average yields of varieties of flax grown on the Belle Fourche Experiment Farm in the 6-year period, 1912 to 1917, inclusive.*

Group and variety.	C. I. No.	Yield per acre (bushels).							
		1912	1913	1914	1915	1916	1917	Average.	
								1912 to 1917.	1914 to 1917.
Seed flax:									
Select Russian (N. Dak. No. 608)	1	.....	.....	3.7	.....	.....	.....	.....	.....
Damont (N. Dak. No. 1215)	3	.....	.....	11.8	14.5	10.7	15.1	.....	13.0
Frontier	17	10.1	.....	.....	.....	.....	.....	.....	.....
Russian (N. Dak. No. 155)	19	12.5	5.3	10.0	a 14.1	12.7	13.6	11.3	12.6
Common	.....	11.3	.....	.....	.....	.....	.....	.....	.....
North Dakota Resistant No. 52	8	11.9	4.8	5.8	a 13.6	10.7	12.9	9.9	10.7
Short fiber:									
North Dakota Resistant No. 114	13	.....	.....	11.1	a 12.4	6.5	11.4	.....	10.3
Primost (Minn. No. 25)	12	11.1	5.3	11.6	12.9	9.0	10.0	10.0	10.9
Smyrna:									
Turkish	7	.....	4.4	1.5	.....	.....	.....	.....	.....
Smyrna	30	.....	.....	.....	6.0	4.1	.....	.....	.....

a Damaged by hail.

VARIETAL TEST OF CORN.

In 1917 seven varieties of corn were tested on irrigated land. The varieties were grown in triplicate plats two rows wide and 132 feet long. Table XXIII shows the results, air-dry weights being given.

TABLE XXIII.—*Average yield of varieties of corn grown on the Belle Fourche Experiment Farm in the 5-year period, 1913 to 1917, inclusive.*

Variety.	Yield per acre (bushels).					
	1913	1914	1915	1916	1917	Average, 1913 to 1917.
Marten White Dent	60.4	45.4	23.7	38.8	45.9	42.8
Northwestern Dent	56.2	31.5	34.1	42.2	49.8	42.7
Gehu Flint	.....	.....	28.7	46.6	44.1	39.8
Payne White Dent	55.3	37.4	22.2	43.8	45.9	40.9

The three varieties, Northwestern Dent, Payne White Dent, and Gehu Flint, seem well adapted to local conditions and have matured

well every year. Gehu Flint is the earliest ripening of all varieties and is a good kind to plant for early hogging off. Marten White Dent is a good variety, but is a little late in ripening for local conditions.

TEST OF CORN AND SUNFLOWERS FOR SILAGE.

In 1917 four varieties of corn and one variety of sunflower (Mammoth Russian) were seeded on land that had been in grain the previous season, had been manured at the rate of 12 tons per acre, and was plowed in the fall of 1916. Each variety was seeded in tenth-acre plats replicated four times. The yields of corn per acre were as follows: Marten White Dent, 9.55 tons; Payne White Dent, 10.37 tons; Red Cob, 11.98 tons; Sweet Fodder, 8.67 tons. The average yield of the sunflowers was 12.59 tons per acre.

The corn was planted on June 10 and harvested on September 21. Payne White Dent was the most nearly mature of the corn varieties, but all were in the glazing stage. The seeds on the sunflowers were also nearly matured on September 21. Of the corn varieties the Red Cob produced the largest yield per acre, 11.98 tons.

TREE PLANTING.

Tests of various kinds of trees for shade, ornamental, and windbreak use have been carried on in cooperation with the Forest Service since 1909. During the first three years all work was done above the canal. In 1912 plantings were begun on irrigated land. All the species came through the winter of 1916–17 without any winter-killing. The Russian white olive was damaged to some extent by rabbits.

DRY LAND.

Table XXIV shows the species that have survived, the date planted, and the maximum season's growth of each species.

TABLE XXIV.—*Results with dry-land experimental tree plantings on the Belle Fourche Experiment Farm in 1917.*

Species.	Date planted.	Height, fall of 1916.	Growth in 1917.	Total height.	Species.	Date planted.	Height, fall of 1916.	Growth in 1917.	Total height.
		Ft. In.	*Inches.*	*Ft. In.*			*Ft. In.*	*Inches.*	*Ft. In.*
Siberian peatree.	1909	4 10	10	5 8	Honey locust....	1909	7 4	10	8 2
Russian white olive.....	1909	8 0	12	9 0	Green ash.....	1909	7 0	7	7 7
White elm.....	1909	7 10	12	8 10	Red cedar.....	1909	4 5	6	5 0
Hackberry.....	1910	7 0	15	8 3	Black Hills spruce.....	1909	2 0	4	2 4

The early part of the season was very favorable to trees, as there was an abundance of rainfall. The midsummer and fall were exceptionally dry, and all the trees ripened up rather too early. As in previous years, the honey locust withstood the drought the best of all

the species. The observations covering eight years with dry-land tree planting indicate that the land where the trees are to be planted must be thoroughly subdued previous to planting. This can be done by using a cultivated crop, but preferably by summer fallowing. Of the surviving species reported in Table XXIV the following seem the most desirable: Honey locust, green ash, Russian white olive, red cedar, and Siberian pea tree. One or two year old stock is preferable to larger sizes, as it is cheaper and much more easily established than older trees. A satisfactory distance to plant is to have the rows 8 feet apart and the trees 4 feet apart in the row. This will allow for cross cultivation with a 1-horse cultivator and for the use of a plow or spring-tooth harrow between the rows. The ground must be kept clean of weeds at all times. With close planting, very little pruning is necessary, the ground will be shaded quickly, and forest conditions soon become established.

IRRIGATED LAND.

About 7 acres are used for testing trees under irrigation for windbreak purposes. Plantings were begun in 1912. Table XXV shows the species of trees and their date of planting, their total height, and the season's growth in 1917.

TABLE XXV.—*Species, date of planting, and record of growth of trees in the irrigated forestry experiment on the Belle Fourche Experiment Farm in 1917.*

Species.	Date planted.	Height, fall of 1916.	Growth in 1917.	Total height.	Species.	Date planted.	Height, fall of 1916.	Growth in 1917.	Total height.
		Ft. In.	*Inches.*	*Ft. In.*			*Ft. In.*	*Inches.*	*Ft. In.*
Golden willow	1914	9 0	24	11 0	Honey locust	1914	5 5	38	8 7
Chinese elm	1912	15 8	30	18 2	Box elder	1914	5 0	22	6 10
Chinese poplar	1912	10 6	16	11 10	Bull pine	1914	9	3	1 0
White willow	1912	13 3	24	15 3	Jack pine	1914	2 2	11	3 1
Caragena	1913	5 6	12	6 6	Black Hills spruce	1916	4½	3	7½
White elm	1912	8 0	18	9 6	White cedar	1916	9	4	1 1
Green ash	1912	7 10	17	8 7	Russian olive	1913	9 0	36	12 0
Cottonwood	1914	8 2	25	10 3					

The trees were irrigated on July 27 and October 4. Trees seem to be less subject to winterkilling if they go into the winter with a good supply of moisture. Some of the cottonwood and elm trees were girdled by mice underneath the straw during the winter, and for this reason mulching probably is not a desirable practice. The recommendations for planting are the same as for dry land, but there can be a wider range of species. For a quick-growing windbreak, cottonwood, poplars, and willows can be used. The species in the windbreak may be arranged in the following order: Four or five rows of cottonwoods and poplars in the center, flanked on either side by white elm, honey locust, green ash, Russian olive, and Siberian pea trees. Evergreens like bull pine and white cedar can be planted in the rows between the poplars and the cottonwoods. It takes

three or four years for evergreens to get well established, and as the ground is needed the cottonwoods and poplars can be cut out. Evergreens are excellent for windbreak purposes, and once they are well established they make rapid growth. Much better success has been had with evergreens when planted with other trees that afford them protection than when planted alone.

ORNAMENTAL PLANTING.

For trees for ornamental planting the Chinese elm and Chinese willow are both good. These trees are not common with nurserymen, but a limited supply usually can be obtained from the Office of Foreign Seed and Plant Introduction, United States Department of Agriculture, Washington, D. C. The following shrubs can be recommended for ornamental planting: Buckthorn, high-bush cranberry, common snowball, hydrangea, Van Houtte's spirea, spirea opulifolia, yellow currant, golden elder, common elder, and lilac.

SMALL FRUITS.

Small fruits adapted to northern latitudes have been grown successfully at the experiment farm for the last three years. To grow small fruits successfully it is of the utmost importance to prepare the land in the best possible manner previous to planting. The land should be heavily manured with well-rotted barnyard manure in the fall and plowed, and after plowing it should be manured again and double disked. In the spring, double disk, harrow, and flood the ground previous to planting.

STRAWBERRIES.

The strawberry is the most important of the small fruits which have been tried at the experiment farm. The Progressive, a variety of the everbearing type, has been tested here and has a fruiting season from late June until the first frost in the fall. Other varieties that have been tested are the Dunlap, Crescent, Warfield, Haverland, and South Dakota. In rows 100 feet long, on second-year picking the following yields were obtained: Dunlap, 30 quarts; Crescent, 24 quarts; Warfield, 51 quarts; Haverland, 30 quarts; South Dakota, 51 quarts; and Bederwood, 30 quarts. Of these varieties, the Warfield is the best as to yield and quality of berries. The South Dakota yields well, but the berries are small, rather soft, and do not keep well. Varieties of the everbearing type seem to be the most desirable for the home garden. They will not produce so much fruit at any one picking as the other varieties mentioned, but will yield a good deal more for the season. On 100-foot rows, first-year picking, the Progressive variety of this type produced 31 quarts, while the Haverland produced 14 quarts and the Warfield 8 quarts.

Early spring planting is the best, and only plants produced the previous season should be used. The rows are marked out 4 feet

apart, but before planting a lister is run between the rows. The plants are set out on the ridges 18 to 24 inches apart in the row. This affords better irrigation and cleaner berries than where irrigation by flooding is practiced. The bed must be kept clean by cultivation and hoeing. Generally by fall the spaces between plants in the row have been covered and there is a solid row, 12 or more inches wide. After the ground freezes in the fall the strawberry bed should receive a covering of about 3 inches, so as to prevent frequent freezing. The mulch may be straw, hay, or cornstalks, preferably using material that is relatively free from seeds of any kind. The plants should be uncovered in the spring, and some of the mulch may be left between the plants. This will help to hold the moisture and also keep the berries clean.

The best yields have been obtained the second season after planting. After the third year they become sodbound and do not do well. They may be renovated by plowing between the rows, leaving a strip of about 6 or 8 inches, and hoeing out the old plants in the row, but better success can be had by planting a new bed each year.

RASPBERRIES.

The following varieties of raspberries have been tested at the experiment farm: Louden, Sunbeam, Cuthbert, Marlboro, Miller, Ohio, and Gregg. These were planted on well-prepared ground in rows 6 feet apart and 3 feet apart in the row. None of these varieties is safe in the winter without covering, not even the Sunbeam, which is generally advertised as winter hardy. The varieties that have given the best yields are the Miller, Ohio, and Gregg.

CURRANTS.

The following varieties of currants have been tested: Cherry, London, Red Dutch, White Grape, Fay, and Perfection. They were planted 3 feet apart in rows 6 feet apart. Those yielding best were the Red Dutch, London, and White Grape.

GOOSEBERRIES.

The following varieties of gooseberries have been tested at the experiment farm: Carrie, Pearl, Champion, and Downing. These were planted 3 feet apart in rows 6 feet apart. Of these varieties, the Champion gave the best yield. It takes about three years for raspberries, currants, and gooseberries to come into full bearing.

Approved:

WM. A. TAYLOR,
Chief of Bureau.

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